IMPLEMENTATION OF FORENSIC ASSISTANCE SOFTWARE

Major project design report submitted to CUSAT in partial fulfillment of the requirements for the award for the degree of

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BONAFIDE CERTIFICATE

This is to certify that the project report entitled "IMPLEMENTATION OF FORENSIC ASSISTANCE SOFTWARE" has been submitted by Akthar Naveed V, Anagha P, Arun Dinesan, Cicy K Agnes, and Sreemikhil T Manoharan in partial fulfillment of the requirements for the award of the degree B.Tech in COMPUTER SCIENCE AND ENGINEERING of COCHIN UNIVERSITY OF SCIENCE AND TECHNOLOGY.

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1: INTRODUCTION

1.1 GENERAL INTRODUCTION

A culprit can be easily identified and brought to trial by using a face sketch drawn based on the statement provided by an eyewitness; however, in this day and age, the traditional method of hand drawing a sketch is not found to be as effective or time-saving when used for matching and identifying from already available databases or real-time databases.

An important application of face recognition is to assist law enforcement. Automatic retrieval of photos of suspects from the police mugshot database can help the police narrow down potential suspects quickly. However, in most cases, the photo image of a suspect is not available. The best substitute is often a sketch drawing based on the recollection of an eyewitness. Therefore, automatically searching through a photo database using a sketch drawing becomes important. It can not only help police locate a group of potential suspects, but also help the witness and the artist modify the sketch drawing of the suspect interactively based on similar photos retrieved.

Several strategies have been presented in the past to transform hand-drawn face drawings and use them to automatically identify and recognize the suspect from the police database, but these techniques have not produced the needed accurate results. Apps to make composite face drawings were also launched, but they also had restrictions such as restricted facial characteristics and a cartoonish appearance to the constructed suspect face, making it considerably more difficult to use these applications and get the needed results and efficiency.

Also, when only a partial face (masked face) is given as evidence, it might be difficult to identify the person. There is no technology available in such instances to recreate the full face. This disadvantage causes confusion among investigators since they may apprehend someone who is not guilty but has a similar partial facial feature to the suspect. In this case a face reconstruction application can come to the rescue.

Our proposed project involves the design and development of a forensic assistance software that includes various features to assist the forensic specialist. The features of our proposed system include face sketch drawing tools, face image generation from sketch, face image inpainting, and face sketch identification system. The generative adversarial networks shall be used to generate photo-realistic images from sketches and also for the image completion task. A FaceNet model shall be used to search for a face match from the database. The other features and user interface shall be built using react js, streamlit and python.

INTRODUCTION TO THE TERMS USED

1. Sketches

Fig: The sketch of a person vs his photograph

Artists have a fascinating ability to capture the most distinctive characteristics of human faces and depict them in sketches. Although sketches are very different from photos in style and appearance, we often can easily recognize a person from his sketch. How to synthesize face sketches from photos by a computer is an interesting problem. The psychological mechanism of sketch generation is difficult to express precisely by rules or grammar. The difference between sketches and photos mainly exists in two aspects: texture and shape. An example is shown in Figure above. The patches drawn by pencil on paper have different textures compared to human skin captured on a photo. In order to convey the

3D shading information, some shadow texture is often added to sketches by artists. For shape, a sketch exaggerates some distinctive facial features just like a caricature, and thus involves shape deformation. For example, if a face has a big nose in a photo, the nose drawn in the sketch will be even bigger.

2. **Sketch to face generation**

Forensic sketch to face transformation refers to the process of transforming a sketch of a person's face into a realistic representation of that person's face. This is a demonstration of image-to-image transformation ie., Our goal of sketch-to-image generation is to automatically generate a photographic image of the hand-sketched object. This approach has a wide range of applications in a variety of fields, including art and forensics. In the case of a forensic application, it may be used to better picture the face of a missing person or criminal based on artists' sketches.

3. **Image inpainting**

Image restoration refers to the task of recovering an image from a corrupted sample.

Examples: Inpainting, denoising, etc.

- Inpainting

Image inpainting is a popular and challenging problem in computer vision with applications in image editing and restoring damaged image regions. The damaged image regions may be rectangular patches. Image completion refers to filling missing regions in the image based on the available visual data.

Semantic Inpainting: The corruption method is a missing center patch (eg. 32 × 32);

Example: Inpainting a face image with a black mask

4. **Face recognition**

   Facial recognition is one of the most exciting applications of deep learning. The rise in the adoption of facial recognition systems has been phenomenal in recent years

   Face recognition is the general task of identifying and verifying people from photographs of their face.

- Face Verification. A one-to-one mapping of a given face against a known identity (e.g. *is this the person?*).
- Face Identification. A one-to-many mapping for a given face against a database of known faces *(e.g. who is this person?)*

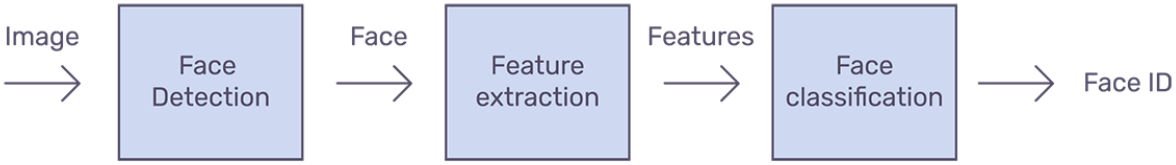


Fig: Face Recognition Pipeline

1. Face detection — Detecting one or more faces in an image.

2. Feature extraction — Extracting the most important features from an image of the face.
3. Face classification — Classifying the face based on extracted features.

USAGE OF GAN IN IMAGE GENERATION TASKS

Image modification has an extensive history, predominantly in regards with the techniques that use handcrafted features rather than deep learning techniques. Such predominance is reflected in commercial image editing software and our practice of its usage. Because most commercial image editing software use defined operations, a typical image modification task requires expert knowledge to strategically apply a combination of transformations for an image. In addition to expert knowledge, users are required to devote long working hours to produce a delicate product. Therefore the traditional approach is disadvantageous for the non-experts and is tedious to use for producing quality results. In addition to these conventional modeling methods, recent breakthroughs in GAN research have developed several methods for completion, modification, and transformation of images by training generative models with suitable data sets.

1.2 OBJECTIVES AND ADVANTAGES

- Provide an all-in-one software application for the crime investigation department for easing forensic image processing tasks.
- Exclude human efforts and save time and resources.
- Reduce the workload by automating face identification tasks
- Provide software platforms and tools to create sketches by automating pencil drawings.
- Generate photo realistic image from sketch
- Avoids taking guesses to find the person in the damaged image

1.3 PROBLEM STATEMENT

Over the years, the crime rate is increasing each and every day and to cope with this the law enforcement departments too should find ways that would speed up the overall process and help them in bringing one to justice. Due to the great difference between sketches and photos and the unknown psychological mechanism of sketch generation, face sketch recognition is much harder than normal face recognition based on photo images. It is difficult to match photos and sketches in two different modalities. One way to solve this problem is to first transform a query sketch into a photo image and then match the synthesized photo with real photos in the gallery. Face photo synthesis not only helps face sketch recognition but also has many other useful applications for digital entertainment.

Currently there is no application available that would provide the assistance to the police to find out a suspect given the description of the suspect or a partial face image. The applications developed so far provide single functionalities. For example, some of them just provide the face recognition feature and there are separate apps in the image editing field developed for sketch creation. Thus, there is a need for creating an application that incorporates different kinds of assistance required for a forensic specialist in order to identify the suspect faster such as the sketch creation, photo generation from sketch, face completion, and facial recognition tools. Our application would help in finding the criminal much faster and efficiently by automating the above tasks in a single place using the latest software techniques.

2: EXISTING SYSTEM

2.1 LITERATURE SURVEY

Face Inpainting:

Yizhen Chen and Haifeng Hu have proposed an upgraded approach for semantic inpainting of images. The proposed method named progressive inpainting using generative models in which they first estimated corrupted image distribution and then moderately refined image details[1] . Jia-Bin Huang and Ahuja have proposed an advance-knowledge approach which used contextual information for image completion. However, in case the corrupted region is large or is irrelevant to visual data, or if the complexity of the image is high, the output of the method would be quite unsatisfactory [2].

Deepak Pathak put forward Context Encoders(CE) which estimated missing areas in images based on their surroundings. However, during training it needed a mask on the corrupted regions of the image, which is a significant disadvantage of the approach, and also context encoders led to blurry and noisy results in the inpainted parts[3].

Peyr proposed an adjustable low-dimensional manifold for images. It included an inpainting task on synthetic as well as texture data. However, the employed work was quite away in giving solutions to real-world images of a face[4]. Raymond and Chen [5] proposed another picture completion technique that can be utilized to fix any state of gaps. In any case, such training depends on the data used in training. In the meantime, the processing of surface and structure was not sufficiently impeccable.

Kai Zhang and Yunjin Chen proposed a picture denoising approach in which they built feed-forward denoising convolutional neural systems using residual learning and batch normalization. However, this methodology was unfit to recover missing regions, and it just denoised the picture. Likewise, it was unfit to refine pictures with genuine complex commotion and other general picture restoration tasks [6].

Interesting work has been done in the field of image inpainting. When the system is fed with masked as well as actual images it identifies the relationship between the masked

region and its unmasked counterparts. Existing work includes image completion of symmetric objects like flowers, birds, etc. GANs have been utilized in applications like generation of anime, inpainting historical monuments, for generating random human faces, etc.

Forensic Sketch-to-image and recognition:

Since the inception of GANs [7], there has been a lot of progress in the field of image-to-image translation. Pix2Pix [8] is a "paired" approach of image-to-image translation. Pix2Pix networks not only learn the mapping from input to output image, but also learn a loss function to train the mapping. These networks are applicable to a wide range of image-to-image translations such as synthesizing photos from label maps, colorizing images, day to night image transformation, and many more as they learn a loss adapted to the task and data at hand.

CycleGAN[9] and DualGAN[10] performed unpaired image-to-image translation. GANILLA[11] improved on existing methods for the application of image to-illustration translation that balance transfer of both style and content of the input image, as they are measured separately in two Convolutional Neural Networks. Like CycleGAN, GANILLA is also an "unpaired" approach where there is no one-to-one mapping between the source and the target image.

There was only limited research work on face sketch recognition because this problem is more difficult than photo-based face recognition and no large face sketch database is available for experimental study. Methods directly using traditional photo-based face recognition techniques such as the eigenface method [12] and the elastic graph matching method [13] were tested on two very small sketch data sets with only 7 and 13 sketches, respectively.

The existing systems in this research area include applications t

2.2 EXISTING SYSTEM AND DISADVANTAGES

hat allow the law enforcement team to upload a previous hand-drawn sketch and identify and recognize the suspect using the deep learning face recognition models. The project named 'Forensic Face Sketch Construction and Recognition' has been designed for use by forensic assistants[14]. It has just used sketch recognition using convolutional neural networks. It also has options and tools to create sketches by selecting and dragging individual features. Also separate models to synthesize photos from sketches have been developed. Hardly any application has been built that provides all the functionalities - sketch creation, photo generation, face inpainting and face recognition.

Also, there are systems that have been proposed for composite face construction but most systems used facial features which were taken from photographs and the operator selects the features as described by the witness and at last compiled to form a single human face making it much more complicated for human as well as any algorithm to match it with a criminal face. As every facial feature was taken from the separate face photographs contain various dissimilarities and when these features are combined together to form a photo, it is harder for the face recognizing systems.

Thus, all the previous approaches proved either inefficient or time-consuming and complicated. Our application as mentioned above would not only overcome the limitations of the mentioned proposed techniques but would also fill in the gap between the traditional hand-drawn face sketch technique and the new modernized composite face sketch technique by letting users upload the hand-drawn face sketches and facial features.

3: SYSTEM DESIGN

3.1 USE CASE DIAGRAM

This use case diagram consists of 2 actors, one is a Forensic Assistant and the other is an Admin. The Forensic Assistant can login by entering the details. As a part of authentication , the system will check the credentials and request the user to complete the OTP verification.
The system will provide use cases:

1) Reconstruct damaged image wherein the user can upload the damaged image and download the suspect's photo after reconstruction,
2) Sketch face using paint tool where the user can either download the sketched image or continue to generate photo from the sketch,
3) Create sketch from drag and drop tool where the user can either download the sketched image or continue to generate photo from the sketch,,
4) Generate a photo from the sketch where the user can either upload a sketch or continue using the sketch created within the system. Also at this stage the user can download the generated photo or continue further to the face match option.
5) Find a face match where the user can either upload a photo or continue using the generated photo or reconstructed photos from the previous steps. It includes provisions to get the details of the similar person from the police database.

The forensic assistant can directly interact with these use cases.
The Admin authorises and verifies the user and also maintains and manages the data of suspects which are stored in the police database.

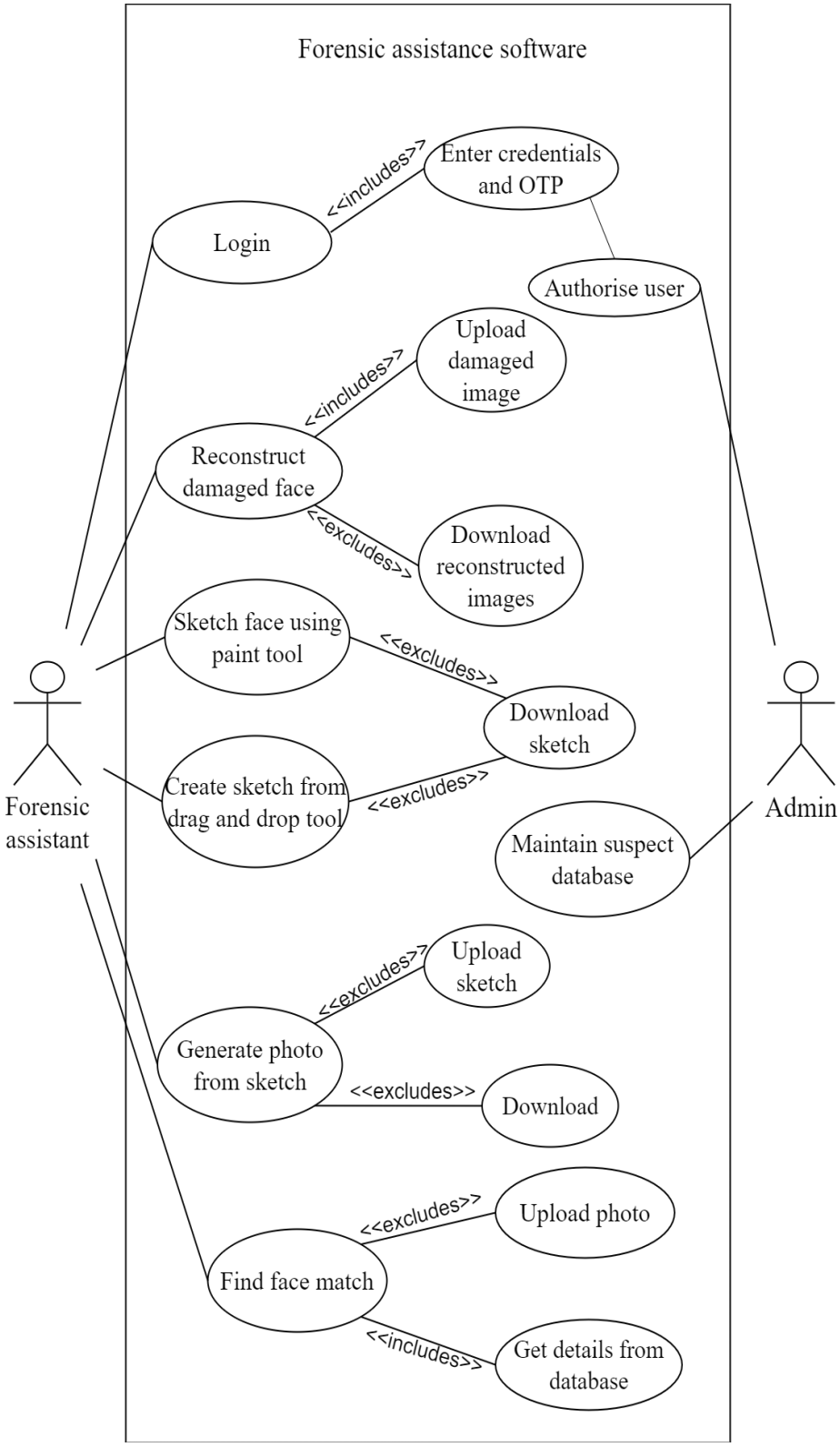


Fig: Use case diagram

3.2 ACTIVITY DIAGRAM

In this diagram, mainly the activities carried by two different sections i.e,the user and the system are showcased. Users enter the credentials and OTP will be generated, after the OTP is entered by the user, the credentials and OTP are verified otherwise, if it is a new user then the user should create a new account. After the login is done, Four option are provided :

1) Create sketch,
2) Photo generation,
3) Face reconstruction,
4) Face matching.

Create sketch: Under Create sketch, sketching tools are given which can perform the tasks-drawing sketch using painting application, and drag and drop facial features to create sketch. The generated sketches can either be downloaded through the download option, or can be passed as an input to the GAN model to create photo realistic images. The output of the GAN can be downloaded. Finally the realistics image is used for face matching and the retrieved results are shown to the user through an output window.

Photo generation: Upon the selection of this option, the sketches are passed to a GAN model to create realistic images. Under photo generation, an image-uploading option is provided to upload the sketch of the suspect. The realistic image generated can be downloaded and as well as can be used as input to the face matching option too.

Face reconstruction: Image uploading option is provided to upload the damaged image for reconstruction purpose. The uploaded damaged image is passed through the Gan model to recreate the image. That recreated image can be downloaded, and can be used for face matching, and to get the details.

Face Matching: User's uploaded image is used for face matching. Details of the most similar person are searched, and retrieved results are shown to the user through an output window.

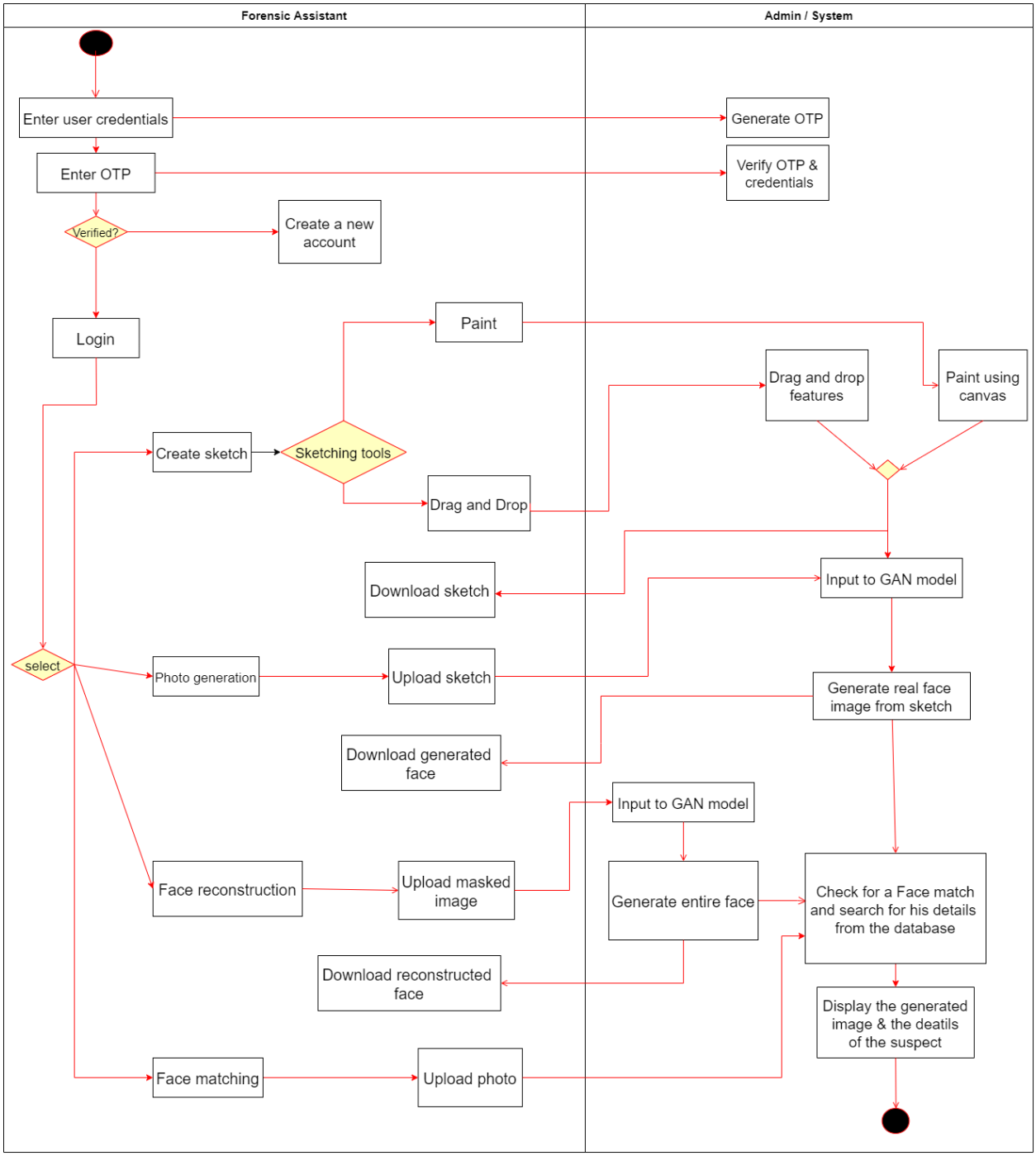


Fig: Activity diagram

3.3 SEQUENCE DIAGRAM

Initially, the forensic assistant enters the login credentials in the interface and then the system validates the details, so that forensic assistant can get access to the user interface .

Through the interface, the user can send the ‘paint-face-tool’ or the ‘drag-and-drop face tool’ message to the instance of SketchTool. Both of these messages are mutually exclusive ie., if the policemen choose to sketch the image manually using the software, he should not use the drag and drop feature and vice versa. The generated sketch image is displayed in the interface and can be downloaded through the DownloadSketch message.

In order to generate realistic images from sketches, first an uploadFaceSketch message is passed to the interface, followed by a message to the instance of sketchToImage for generating the realistic image. The generated image is returned to the user.

Similarly, in order to reconstruct the masked/damaged images, first an UploadDamagedImage message is passed to the interface, followed by the message for reconstructing that image to the instance of FaceReconstructor. The generated image is returned to the user and it can be downloaded through a message to the interface.

For face matching, at first the image to be matched is passed in through the interface. Then a message to perform the face match (FaceMatch) is given into the instance of FaceMatcher. This in turn interacts with the Police DataBase to search for similar face features through the search() message. The resultant details are given back to the forensic assistant.

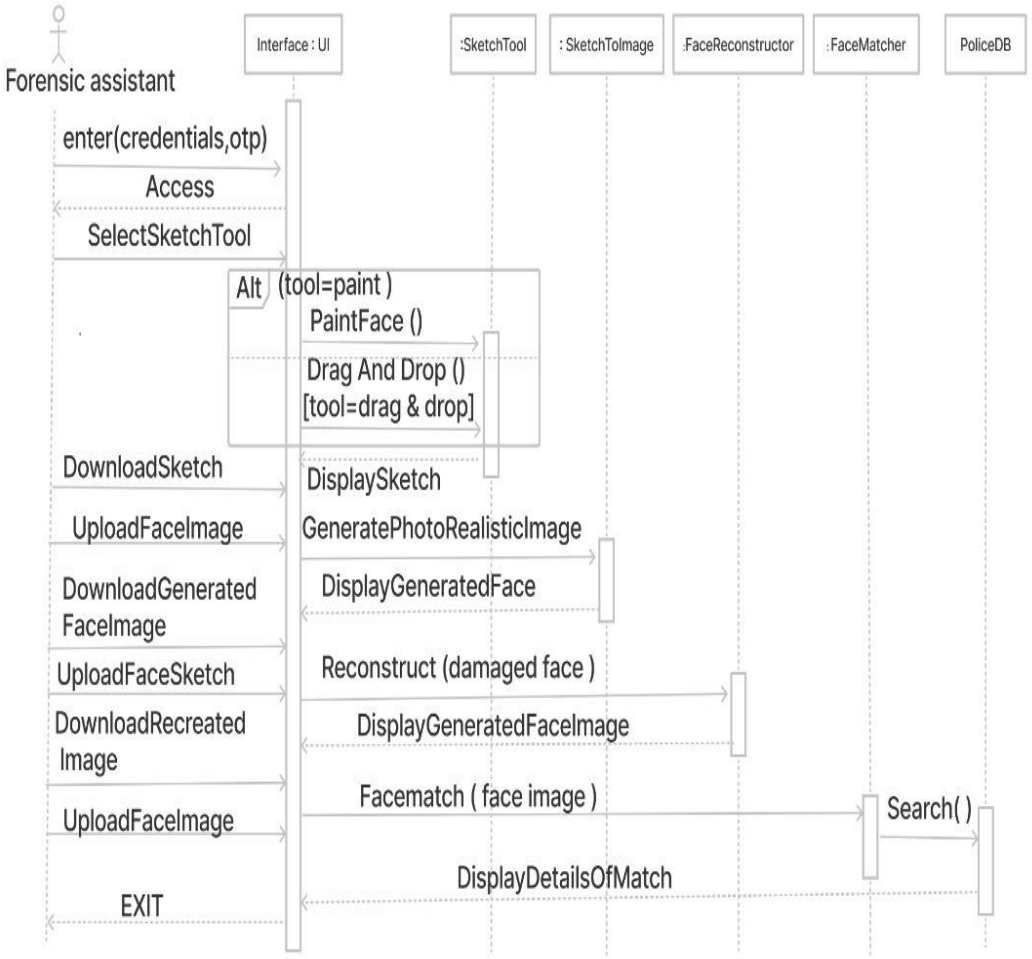


Fig: Sequence diagram

4: REQUIREMENT ANALYSIS

4.1 SYSTEM REQUIREMENTS

4.1.1 Hardware Requirements of user

- Speed : 2.3 GHz.
- RAM : 4 GB(min).
- Hard Disk : 7 GB.
- GPU- GeForce GTX 10 series
- Key Board : Standard Windows Keyboard.
- Mouse : Two or Three Button Mouse.
- Monitor : LCD/LED.
- Display : (800 x 600) Capable video adaptor and monitor
- Internet connection

4.1.2 Software Requirements

- Operating System: Windows(preferable) / Linux/ Apple , Android
- Web browser : Google Chrome / Microsoft Edge / Mozilla / Safari / Opera
- Coding Language : Python

4.1.3 Hardware Requirement During Development

- 25 GB RAM for reconstruction.
- 12 GB RAM for sketch to photo gan.
- Operating System: Windows, Android.
- Graphics Card : GTX 980 or 980 Ms
- Processor : i5 or higher

5: IMPLEMENTATION

5.1 DATASET USED

- Facenet and Sketch to photo generation : CUHK dataset

  It includes 188 faces from the Chinese University of Hong Kong (CUHK) student database, 123 faces from the AR database, and 295 faces from the XM2VTS database. There are 606 faces in total. For each face, there is a sketch drawn by an artist based on a photo taken in a frontal pose, under normal lighting condition and with a neutral expression .
- Face completion: Image Align CelebA HQ dataset

  All the face images are cropped and aligned and it contains 202,599 number of face images of various celebrities

5.2 MODELS

GAN:

Generative Adversarial Networks, or GANs for short, are an approach to generative modeling using deep learning methods, such as convolutional neural networks.

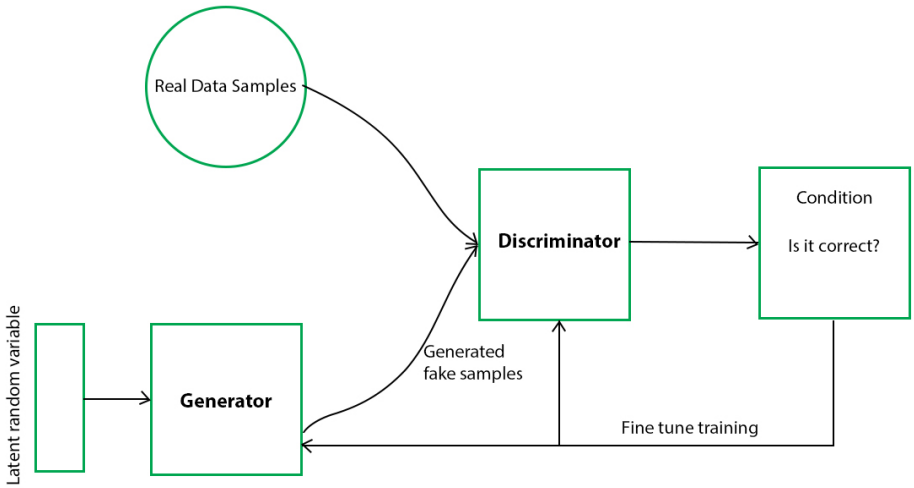
Generative modeling is an unsupervised learning task in machine learning that involves automatically discovering and learning the regularities or patterns in input data in such a way that the model can be used to generate or output new examples that plausibly could have been drawn from the original dataset.

GAN is a generative algorithm. A generative adversarial network (GAN) is a machine learning (ML) model in which two neural networks compete with each other to become more accurate in their predictions. GANs typically run unsupervised and use a cooperative zero-sum game framework to learn. they create new data instances that resemble our training data.

Generative Adversarial Networks (GANs) can be broken down into three parts:

- **Generative:** To learn a generative model, which describes how data is generated in terms of a probabilistic model.
- **Adversarial:** The training of a model is done in an adversarial setting.
- **Networks:** Use deep neural networks as the artificial intelligence (AI) algorithms for training purpose.

In GANs, there is a **generator** and a **discriminator**. The Generator generates fake samples of data(be it an image, audio, etc.) and tries to fool the Discriminator. The Discriminator, on the other hand, tries to distinguish between the real and fake samples. The Generator and the Discriminator are both Neural Networks and they both run in competition with each other in the training phase. The steps are repeated several times and in this, the Generator and Discriminator get better and better in their respective jobs after each repetition. The working can be visualized by the diagram given below:

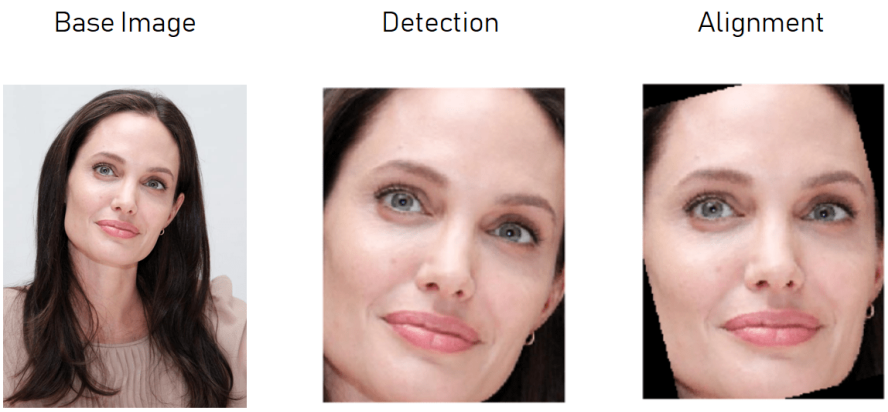


FaceNet:

FaceNet [15] is the name of the facial recognition system that was proposed by Google Researchers in 2015 in the paper titled *FaceNet: A Unified Embedding for Face Recognition and Clustering*. The FaceNet system can be used to extract high-quality features from faces, called face embeddings, that can then be used to train a face identification system.

To develop a face recognition system, the first step is to find the bounding box of the location of faces. Then find the spatial points of facial features such as length of eyes, length of mouth, the distance between eyes and nose, etc. Then transform the face into a frontal face, because an image of a person could be taken in different views. Finally, create embeddings from facial features extracted and calculate the distance between two embeddings.

Face Detection



Face detection is similar to object detection. It is the process of automatically detecting the location of faces and localizing by drawing a bounding box in the image. Top, left, bottom, and right coordinates of the face are returned by the face detection algorithm MTCNN (Multi-Task Cascaded Convolutional Neural Network). The aligned face is the output of MTCNN and is given as input to FaceNet.

Face Recognition Using FaceNet Model

Face recognition is the process of identifying a person from a digital image or a video. This is a 1:K matching problem. A use case for this could be marking employee attendance when an employee enters the building by looking up their face encodings in the database. The FaceNet model expects a 160x160x3 size face image as input, and it outputs a face embedding vector with a length of 128. This face embedding contains information that describes a face's significant characteristics. Then, FaceNet finds the class label of the training face embedding that has the minimum L2 distance with the target face embedding. It is the shortest distance between two points in an N dimensional space also known as Euclidean space.

The Convolutional Neural Network model uses the Triplet Loss function. This function returns a smaller value for similar images and larger value for dissimilar images.

5.3 TOOLS / TECHNOLOGY USED

Python: Python is an interpreted, object-oriented, high-level programming language with dynamic semantics. It has high-level built-in data structures, combined with dynamic typing and dynamic binding, make it very attractive for Rapid Application Development, as well as for use as a scripting or glue language to connect existing components together.

Tensorflow: It is an open source artificial intelligence library, using data flow graphs to build models. It allows developers to create large-scale neural networks with many layers. TensorFlow is mainly used for: Classification, Perception, Understanding, Discovering, Prediction and Creation.

Keras: Keras is a high-level, deep learning API developed by Google for implementing neural networks. It is written in Python and is used to make the implementation of neural networks easy. It also supports multiple backend neural network computation.

Firebase: Google Firebase is a Google-backed application development software that enables developers to develop iOS, Android and Web apps. Firebase provides tools for tracking analytics, reporting and fixing app crashes, creating marketing and product experiments. There are many services offered. The one we use was:

Realtime database – the Firebase Realtime Database is a cloud-hosted NoSQL database that enables data to be stored and synced between users in real time. The data is synced across all clients in real time and is still available when an app goes offline.

AWS: Amazon Web Services, Inc. (AWS) is a subsidiary of Amazon that provides on-demand cloud computing platforms and APIs to individuals, companies, and governments, on a metered pay-as-you-go basis. These cloud computing web services provide distributed computing processing capacity and software tools via AWS server farms.

React: React is a JavaScript library for building user interfaces. React is used to build single-page applications. React allows us to create reusable UI components.

OpenCV: OpenCV is a library of programming functions mainly aimed at real-time computer vision. Originally developed by Intel, it was later supported by Willow Garage then Itseez. The library is cross-platform and free for use under the open-source Apache 2 License.

Streamlit: Streamlit is an open source app framework in Python language. It helps us create web apps for data science and machine learning in a short time. It is compatible with major Python libraries such as scikit-learn, Keras, PyTorch, SymPy(latex), NumPy, pandas, Matplotlib etc.

Matplotlib: Matplotlib is a plotting library for the Python programming language and its numerical mathematics extension NumPy. It provides an object-oriented API for embedding plots into applications using general-purpose GUI toolkits like Tkinter, wxPython, Qt, or GTK.

NumPy: NumPy is a library for the Python programming language, adding support for large, multi-dimensional arrays and matrices, along with a large collection of high-level mathematical functions to operate on these arrays.

Pandas: Pandas is a software library written for the Python programming language for data manipulation and analysis. In particular, it offers data structures and operations for manipulating numerical tables and time series. It is free software released under the three-clause BSD license.

MTCNN: MTCNN or Multi-Task Cascaded Convolutional Neural Networks is a neural network which detects faces and facial landmarks on images. It was published in 2016 by Zhang et al.MTCNN is one of the most popular and most accurate face detection tools today.

First Order Motion Model for Image Animation: Image animation consists of generating a video sequence so that an object in a source image is animated according to the motion of a driving video.

SciPy: SciPy is a free and open-source Python library used for scientific computing and technical computing. SciPy contains modules for optimization, linear algebra, integration, interpolation, special functions, FFT, signal and image processing, ODE solvers and other tasks common in science and engineering.

Colab: Colaboratory, or “Colab” for short, is a product from Google Research. Colab allows anybody to write and execute arbitrary python code through the browser, and is especially well suited to machine learning, data analysis and education.

SQLite3: SQLite is a C library that provides a lightweight disk-based database that doesn't require a separate server process and allows accessing the database using a nonstandard variant of the SQL query language.

5.4 BACKEND IMPLEMENTATION

- **Image recognition:**

- Image recognition was implemented based on a Facenet paper using keras as a framework.
    1. Dataset of images was made using a deepfake pretrained model due to insufficient data.Dataset contains 187 individuals and 16 images per each person.
    2. Batch was created by randomly picking individuals' photos and mixing it with each 16 image per individuals Overall 99 images per each batch.
    3. Model was constructed by modifying inception net,Facenet architecture contains inception net,normalizing layer and finally triplet loss layer.
    4. Image was taken from the user then it was passed through the pretrained MTCNN network to detect the face and cropped face was reshaped into (185,185) shape.
    5. Output from MTCNN was passed through the facenet network at the normalizing layer data was normalized between 0 and 1,and 128. Dimensional embeddings were produced
    6. Batch hard triplet pairs were selected for training trained over 187 batch
    7. Trained model are integrated using streamlit framework

- **Image reconstruction:**
    1. We used the DCGAN model architecture .The 4 generative model, G, takes a random 100 dimensional vector drawn from a uniform distribution between [−1, 1] and generates a 64×64×3 image.

2. The discriminator model, D, is structured essentially in reverse order. The input layer is an image of dimension 64 × 64 × 3, followed by a series of convolution layers where the image dimension is half, and the number of channels is double the size of the previous layer, and the output layer is a two class softmax.
3. For training the DCGAN model, we follow the training we used Adam optimizer and learning rate of 0.003
4. Backpropagation to the input data is used in our approach.
5. After generating the image from G ,the result was obtained overlaying the uncorrupted pixel from the input.Opinion blending is used to obtain the final results.

- **Image generation from sketch:**
    1. From the dataset images where stored in two files - an image file and a sketch file
    2. Then we converted the image from BGR to RGB format using OpenCV.
    3. The image was then resized into [256,256] and normalized.
    4. To augment the both image and sketch files ,it was first flipped horizontally, then flipped vertically and was then followed by a horizontal and vertical flip,And it was saved each time.
    5. These file where divided into test and train set each with 52 and 700 images respectively
    6. Then a generator was created with 7 convolution layers (stripes=2,filter=64,128,256,512,512,512,512) for downsampling and 7 deconvolutional layers for upsampling.
    7. The discriminator model was made of 4 convolutional layers,
    8. LeakyReLu,DropOut and InstanceNormalization layers were also used.
    9. The generator and discriminator were trained adversarially using the sum of pixel and conduction loss.
    10. The model was trained for 100 epoches and took 4 hours for its completion.

5.5 FRONTEND IMPLEMENTATION

- The web application was made using the Python framework-Streamlit.It uses the port number 8501.The above models were integrated into the application .
- The security and authentication was done using Firebase with a phone verification via otp.In firebase two authentication were carried out-user authentication and page authentication.The user authentication was done using OTP and the page authentication was done creating user id for every user after user authentication.
- The whole software was deployed into cloud using AWS(Amazon Web Service)
- The sketch creation was programmed using React .
- The API references of Streamlit were used to style the software.

5.6 WORKING OF THE SYSTEM

1. **User Verification**: The forensic assistant can create an account in the system by creating their own usernames and passwords. These can be used to login into the system later. Their emails will be linked to the system and each time they log in, an OTP will be generated and sent to their phone which will be verified to gain access into the system.

2. **Sketch Tool**

   -Three options are provided as sketch tools:

   - **Painting Tool:** For expert artists, a painting tool is provided by the system. This is a paint-like app with different pencils and brushes, a myriad of colors and different tools to draw the sketch images.
   - **Drag and Drop Tool:** This feature helps to make the task of drawing much more simple so that non-experts can also develop sketches using our software. Various face features which are in-built will be provided. All that the users

should do to develop a suspect's sketch would be to drag and drop those features appropriately into the canvas.

- **Direct Image Upload:** Upload option is also given for uploading the hand-drawn sketches and, for image reconstruction, uploading the damaged image can be done through this option.

3. **Sketch To Image Generation**
    - The sketched image (user input) is passed to the **GAN** model for generating photo realistic coloured images
    - The colored realistic images generated can be downloaded
4. **Face Completion**
    - The damaged incomplete image is uploaded to the software
    - Then it is given into the **GAN** model for recreating the complete image.
    - The generated (recreated) image is obtained as the result and this image can be downloaded.
5. **Face Identification**
    - The generated image is then fed into the **Facenet** model for searching and finding details of the person with the most similar face present in the database.
    - The retrieved details are displayed to the user

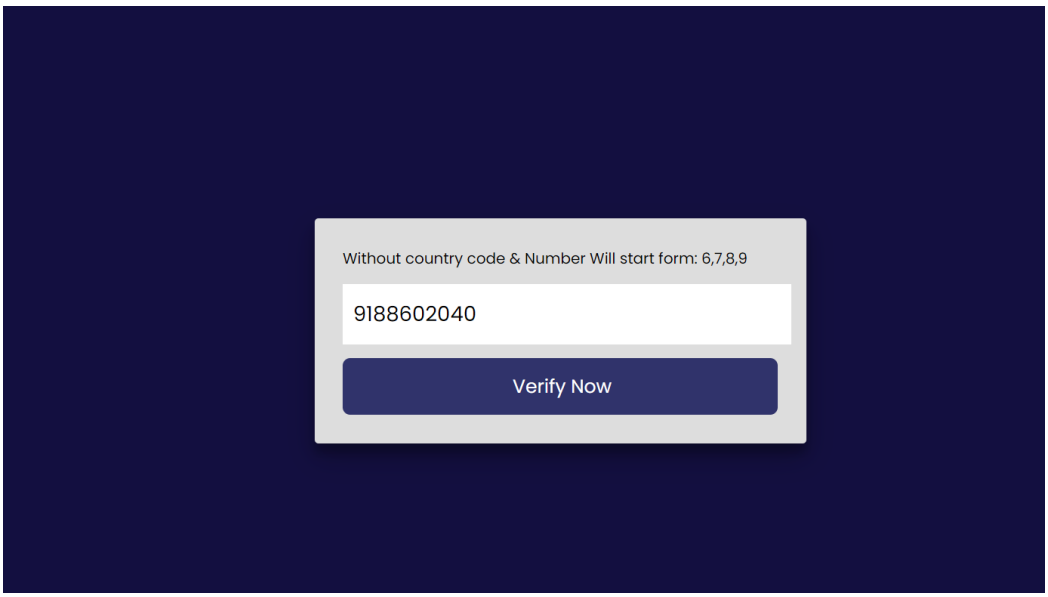
6. APPLICATION

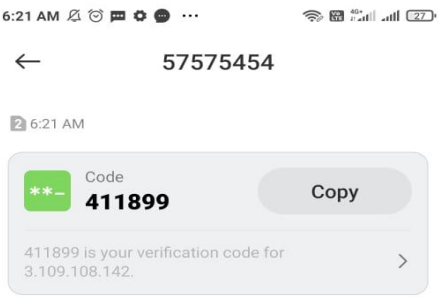
1. Generating photorealistic images from sketched images or damaged images has tremendous application ,including criminal identification,civil engineering,photo editing etc.
2. This software can also be used for recreating old pictures,cctv image identification ,photo editing, biometric verification etc
3. **Civil engineering** : The sketch of buildings can be converted into photorealistic images
4. **Biometric verification** :A facial recognition system uses biometrics to map facial features from a photograph or video.And we can implement the image recognition feature to identify the person.
5. **CCTV** : The pictures captured through CCTV can be used to recognize the actual person in the visuals.

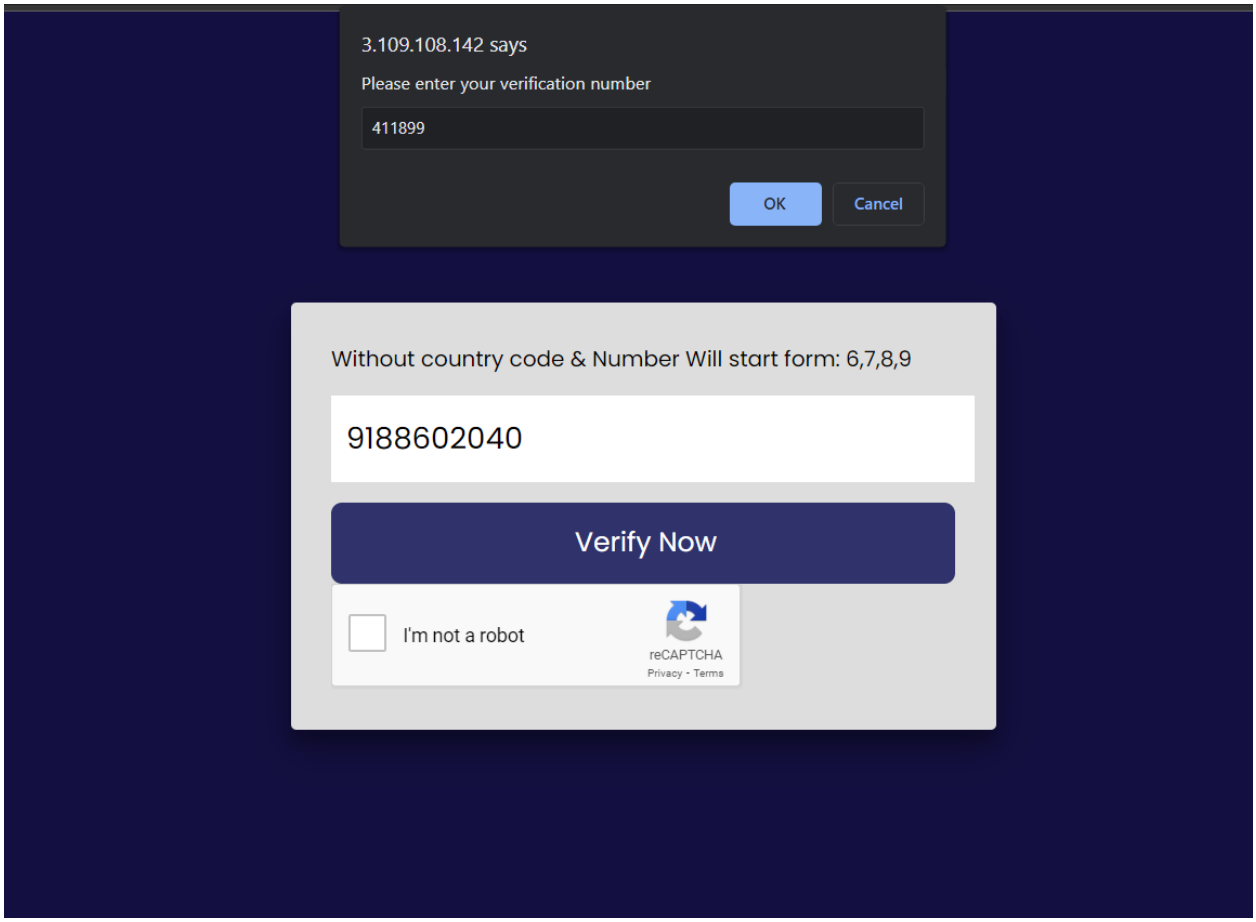
7. RESULT

1. WEB APPLICATION

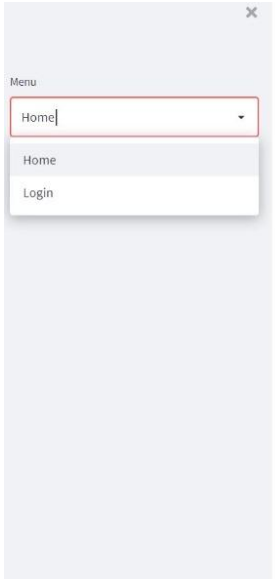
- LOGIN
    - OTP AUTHENTICATION





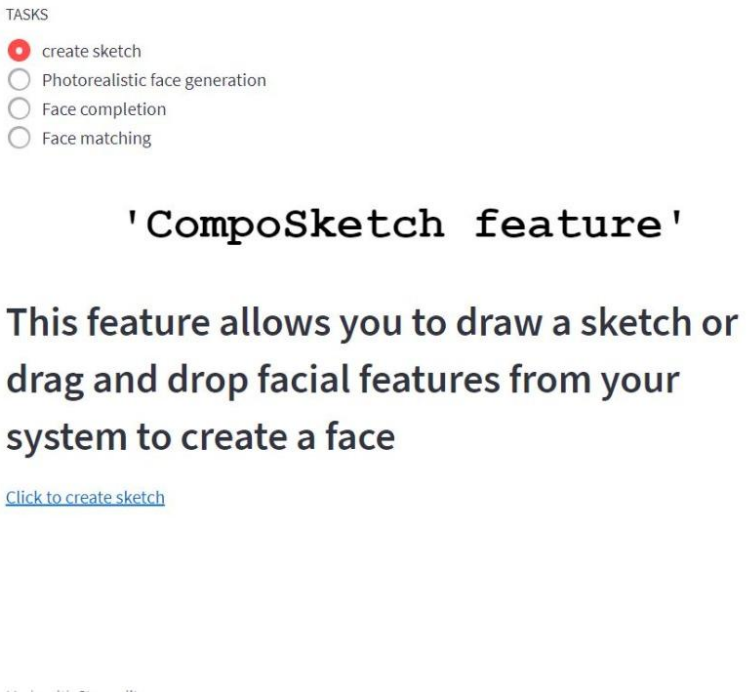

3.109.108.142 says
Please enter your verification number
411899
OK
Cancel
Without country code & Number Will start form: 6,7,8,9
9188602040
Verify Now
I'm not a robot
reCAPTCHA
Privacy - Terms

- HOME


Menu
Home
Home
Login

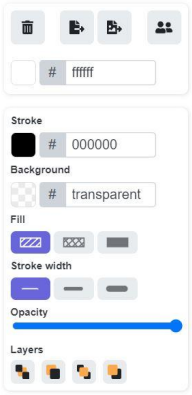

FORENSIC
ASSISTANCE
SOFTWARE

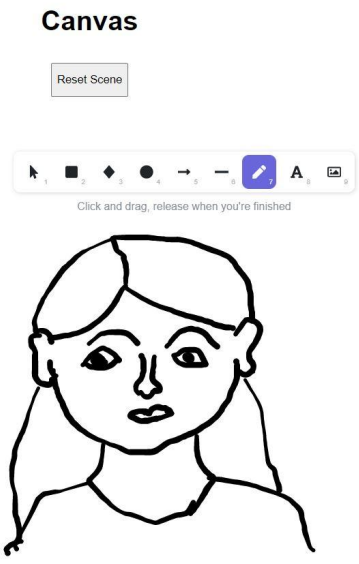
- MENU



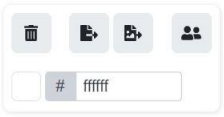
- CREATE SKETCH

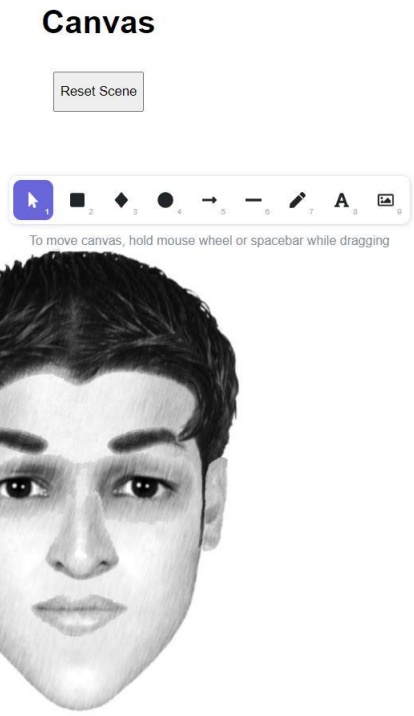
  - PAINT TOOL





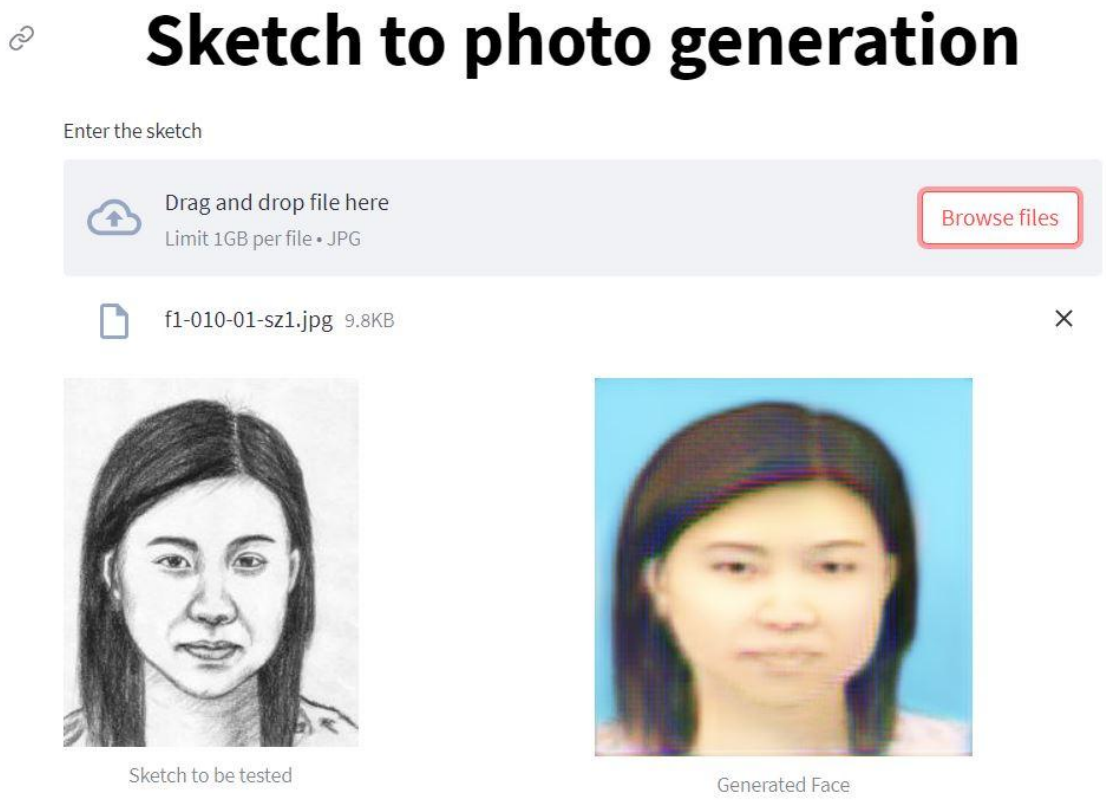
- DRAG AND DROP



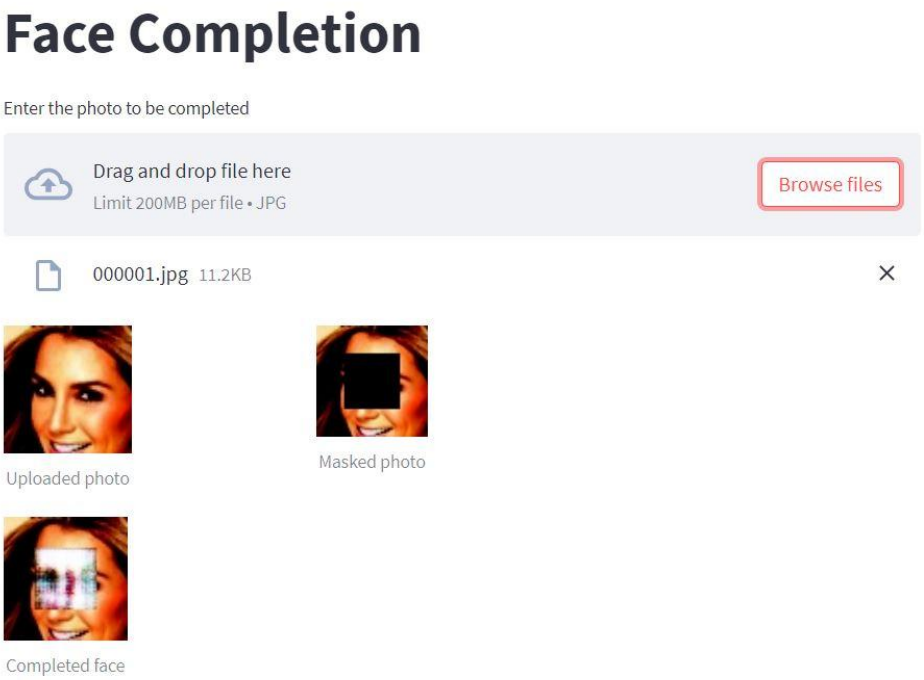


- PHOTOREALISTIC FACE GENERATION

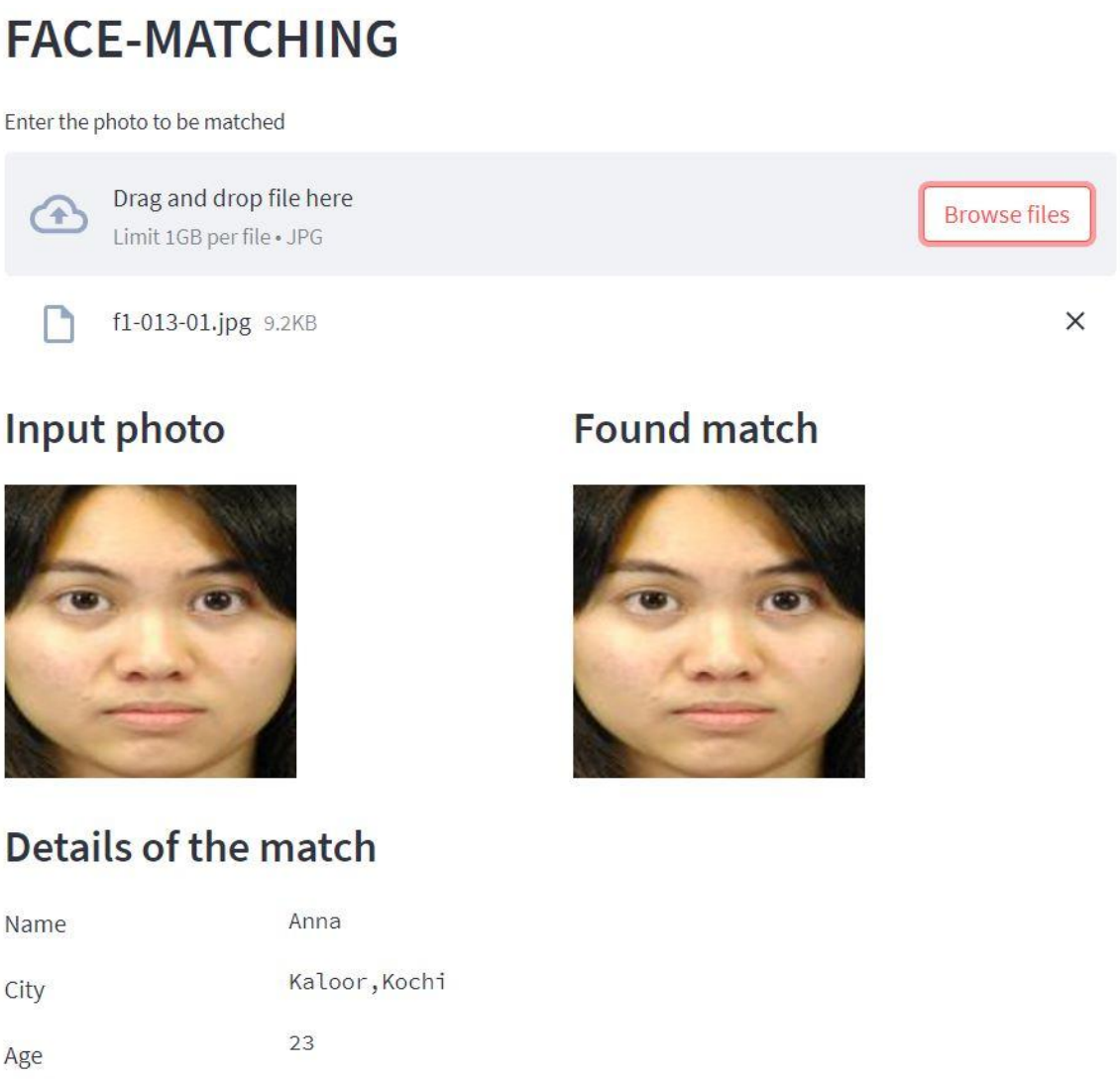
    - SKETCH TO IMAGE



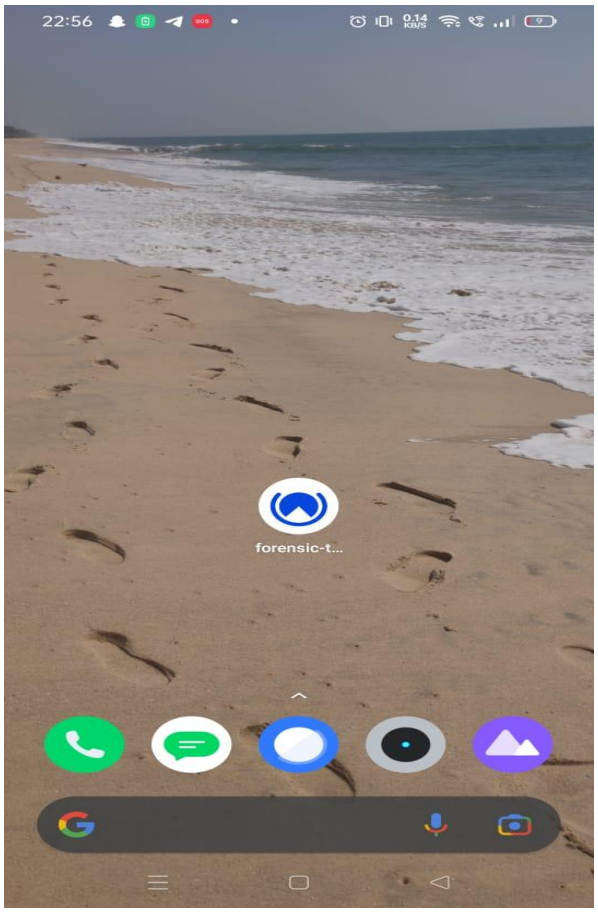
- FACE COMPLETION



- FACE MATCHING



2.MOBILE APPLICATION



8: CONCLUSION

There are several problems faced by the forensic department due to the increasing number of cases and lack of time to investigate. To the best of our knowledge, these problems have not been addressed in a single place. The past attempts were not promising to solve all the problems of the policemen. Each had its own disadvantages. Though there were several studies in the field a complete automating system has not yet been developed. The forensic investigators have to manually draw realistic images of the suspects and examine the database to find the person. Also, if the image is damaged the wrong person might be accused. With all these problems in line, we have come up with a unique solution, the Forensic assistant software. It is an AI based application for forensic experts. It has provisions to create sketches by using its in builts facial features or by drawing the sketches using the software that our software provides. It can easily draw sketch images and generate realistic colored photos using deep learning technology. The software identifies the victim and helps in retrieving information regarding the identified person from the database. Also, it provides provisions to complete the damaged images. With all these features, this software automates a bunch of tasks and hence the forensic experts can easily make decisions during the critical solution and save a lot of time.

9.FUTURE SCOPE

The Project ‘Implementation of Forensic Assistance Software’ is currently designed to work on very few scenarios like on face sketches and matching those sketches with the face photos in the law enforcement records.

The platform can be much enhanced in the future to work with various technologies and scenarios enabling it to explore various media and surveillances medium and get a much wider spread and outputs, The platform can be modified to match the Face sketch with the human faces from the video feeds by using the 3D mapping and imaging techniques and same can be implemented to the CCTV surveillances to perform face recognition on the Live CCTV footage using the Face Sketch.

The platform can further be connected to social media has social media platforms acts has a rich source for data in today’s world, this technique of connecting this platform with the social media platform would enhance the ability of the platform to find a much more accurate match for the face sketch and making the process much more accurate and speeding up the process.

In all the platform could have features which could be different and unique too and easy to upgrade, when compared to related studies in this field, enhancing the overall security and accuracy by standing out among all the related studies and proposed systems in this field.

10.REFERENCES

1. Yizhen Chen and Haifeng Hu, “An improved method for semantic image inpainting with gans:Progressive inpainting,” Neural Processing Letters, Springer, pp. 1–13, Jun 2018.
2. Jia-Bin Huang and Ahuja, “Image completion using planar structure guidance,”ACM Transactions on Graphics (Proceedings of SIGGRAPH), vol. 33(4), August 2014.
3. Deepak Pathak and Philipp Krahenbuhl, “Context encoders: feature learning by inpainting,” Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition, pp. 2536–2544, 2016
4. Gabriel Peyr,“Manifold models for signals and images,” Computer Vision and Image Understanding, vol. 113(2), pp. 249–260, 2009.
5. Raymond A. Yeh, Chen Chen, Teck-Yian Lim, Mark Hasegawa-Johnson and Minh N.Do, “Semantic image inpainting with perceptual and contextual losses,” CoRR, abs/1607.07539,2016.
6. K. Zhang, W. Zuo, Y. Chen, D. Meng, and L. Zhang, “Beyond a gaussian denoiser: Residual learning of deep cnn for image denoising,” IEEE Transactions on Image Processing, vol. 26, pp. 3142âĂŞ3155, 2017.
7. I. Goodfellow, J. Pouget-Abadie, M. Mirza, B. Xu, D. Warde-Farley, S. Ozair, A. Courville, Y. Bengio, Generative adversarial nets, in: Advances in neural information processing systems, 2014, pp. 2672– 2680.
8. P. Isola, J.-Y. Zhu, T. Zhou, A. A. Efros, Image-to-image translation with conditional adversarial networks, in: Proceedings of the IEEE conference on computer vision and pattern recognition, 2017, pp. 1125–1134.
9. J.-Y. Zhu, T. Park, P. Isola, A. A. Efros, Unpaired image-toimage translation using cycle-consistent adversarial networks, in: Proceedings of the IEEE international conference on computer vision, 2017, pp. 2223–2232.
10. Z. Yi, H. Zhang, P. Tan, M. Gong, Dualgan: Unsupervised dual learning for image-to-image translation (2017). arXiv:1704.02510

11. S. Hicsonmez, N. Samet, E. Akbas, P. Duygulu, Ganilla: Generative adversarial networks for image to illustration translation, Image and Vision Computing (2020) 103886.
12. R.G. Uhl and N.D.V. Lobo, "A Framework for Recognizing a Facial Image from a Police Sketch," Proc. IEEE Int'l Conf. Computer Vision and Pattern Recognition, 1996.
13. W. Konen, "Comparing Facial Line Drawings with Gray-Level Images: A Case Study on Phantomas," Proc. Int'l Conf. Artificial Neural Networks, 1996.
14. http://www.ijitjournal.org/volume-6/issue-4/IJIT-V6I4P2.pdf
15. Schroff, F., Kalenichenko, D. and Philbin, J., 2015. Facenet: A unified embedding for face recognition and clustering. In *Proceedings of the IEEE conference on computer vision and pattern recognition* (pp. 815-823).
16. @inproceedings{zhang2011coupled,title={Coupled information-theoretic encoding for face photo-sketch recognition},author={Zhang, Wei and Wang, Xiaogang and Tang, Xiaoou},booktitle={Computer Vision and Pattern Recognition (CVPR), 2011 IEEE Conference on},pages={513--520},year={2011},organization={IEEE}.